UNIVERSITY OF HAWAII

Management Systems Office

MEMORANDUM

September 11, 1986

TO: Vice Presidents
Chancellors
Provosts
UHM Deans
University Librarian
UACCT Committee

FROM: Roger G. Angell, Director R.A.

SUBJECT: University of California at Berkeley Academic Computing Plan

Attached for your information is a copy of the subject plan, developed by Dr. Raymond Neff, Assistant Vice Chancellor for Information Systems and Technology.

RGA:ct

Attachment

cc: MSO Manager
Kent W. Bridges

Academic Plan

University of California at Berkeley

Information Systems and Computer Technology

I. <u>The Ubiquitous Computer and the Wired Campus</u>

During the past five years we have witnessed the emergence of the microcomputer as a scholarly tool. Faculty and students are acquiring their own individual computers in larger and larger numbers. At Berkeley we expect that each faculty member who wants a personal computer will be able to have one provided by the campus computing organization without explicit recharge. Students will be able to purchase their own microcomputers at substantial discounts; the campus computing organization will operate a number of microcomputer clusters in various locations across the campus for student use. Microcomputer-based workstations will thus be available to all who would want to use them.

Individual workstations are much more useful when they can be linked to remote information resources. A second element in the development of computing on the Berkeley campus is the provision of a universal communications network that would connect all personal computers to one another and to shared computer systems both on- and off- the campus. Thus, the network would become an integral part of a scholar's environment; it would eventually be taken for granted, like the electrical system. Every workspace would have network access ports, and like electricity, usage of the network would not be recharged.

The microcomputer-based workstation would be a powerful computer in its own right, but it would not be able to do everything. To supplement the micro, the campus would maintain supercomputers and other advanced computational instrumentation for the larger tasks. Again, the communications network would provide the link between the micro and the supercomputer. With any given task being distributed among the various computational elements best able to do the work, and with the network providing the bridge, Berkeley would have the best of both worlds - individual computing with its advantages and shared supercomputing with its advantages. The campus's communications network would also provide access to computers at remote sites.

Progress in commercial telephone technology will make it possible for faculty and students to access the campus communications network from their homes, residence halls, apartments, and other living accommodations. In addition, cable television systems would also handle data transmissions. With either or both communications technologies, the information resources of the campus may be accessed at a distance. The campus would also be able to access information resources at other universities as well as those located in the commercial sector. Many faculty will find it justifiable to have two workstations, one in the office and one at home.

II. Computing and the Library

The University Library is the academic information center of the campus and should remain so. The computer however has a distinctive role to play in the library because the computer offers to both library user and librarian a new function that is wanted: the capability to customize information retrieval to satisfy the library user's particular need.

Computers are supremely efficient at symbol manipulation. With suitable communications capability, they can store, retrieve, borrow, and lend information. In short, computers can do all that a library can do. Computers can do even more: they can rearrange and edit text, they can exhaustively search for particular phrases, they can compare two or more information items, and they can synthesize diverse information from many sources. Thus, the computer can make information dynamic, whereas the library can only make it available.

The electronic library is coming. All publishers are preparing for this eventuality. Already electronic storage of text is more economic and more compact than storage in paper form. Whereas the conventional library takes much effort in managing the physical objects, books, maps, serials, and so forth. The electronic library would never lose a book; circulation control would be a thing of the past because the electronic book would never be out and unavailable to a user.

Books would still be available for convenient reading and study; they would not become obsolete. They would, however, be printed only as needed on the user's local electronic printer. Of course, specialty firms would offer leather-bound volumes when a consumer ordered them. In this way all of the familiar book formats could be preserved, but like paperback publishing, the electronic publisher would distribute much more information than was ever available before and it would be far less expensive to acquire and maintain.

Electronic books, serials, maps will make it possible for faculty to develop customized textbooks for student use in particular courses. Instead of having students acquire several textbooks for a course, so that the instructor may refer to complementary sections from each source, the instructor might instead use the computer to combine the relevant sections from each text and then edit the result to have consistent technical language and symbolism. Of course, only the surface of this activity can be scratched here, but it is important that our academic planning permit such developments when and where they would be judged to be most effective and useful. In no case should the academic plan hinder the innovative use of electronic media.

Libraries are especially well positioned to distribute software to campus users. The library's on-line catalog service would index software in addition to the other campus holdings of information resources.

III. Computing and Other Information Resources

Books and other print media are not the only information packages relevant to scholarship and instruction. Vast bodies of data are collected and archived each year. These data deal with governmental operations, commercial ventures, health care and delivery, and every other sector of society and the physical environment. Our faculty and students are involved in the collection of some of these data; they must have access to every bit of it for their research and study.

Many commercial firms have been formed to make a profitable business of information storage and retrieval services. As more and more information, especially from governments, is distributed only in electronic form it is critical that the academic community have access electronically to this information. These service firms charge for each search request or have some other charging scheme. Libraries have not had adequate budgets for electronic retrieval services, and users of such services have been recharged for such usage. We believe that this recharging is counterproductive to scholarly activities where the mode of information distribution is increasingly in the electronic form. University budgeting for books must be maintained, but budgets for scholarly access to electronic retrieval services must be developed as well.

If we have the electronic library coming along, is there also an electronic museum for natural history collections, art objects of all descriptions, and ethnographic collectibles, to name just some areas, in our future? Some pioneering work in the digitization of images of art objects and those from photographic film are beginning on the campus. From these efforts we may expect to see the development of electronic image collections of all of the important objects and collectibles on the campus and beyond. Students and faculty will be able to sit at their workstations and call forth the images of art works, natural history specimens, anthropological artifacts for study and comparison. Again, the communications network will permit many users to view the images simultaneously and at many different locations.

Other data resources must be accessible including population census data, state, national, and international economic data to name but a few such collections. In addition, particular Berkeley-based data banks should be maintained and access to them increased via communications networking.

An important information resource that is being planned for is computer software itself. The recently formed Campus Software Office (CSO) is coordinating activities for the widest dissemination of campus-developed software. This service is available to software developers and to faculty who direct its creation and maintenance. The CSO will work to acquire software, as well, on the best terms possible. The CSO is only a part of the campus's response to the challenge of protecting the valuable intellectual property that is created and used on the Berkeley campus.

IV. Computing in Humanities

Computing came last to the humanities, but not least in terms of its potential. At Berkeley the Humanities Computing Service exists to support scholarship, and many new activities are underway. The Thesaurus Lingae Graecae, an electronic compendium of all known, important ancient Greek literature is now available for use. Many other data sets are being created in such fields as Spanish Language and Literature and Oriental Studies, an especially challenging area because of the non-roman character sets. Faculty and students are becoming aware of the possibilities for using the recently acquired Kurzweil Data Entry Machine, a sophisticated omnifont character scanner. In the years ahead, more data bases will be created of the important literature requiring study and analysis. Other universities have comparable efforts underway. The exchange of data banks should become possible and routine. The curriculum will have to evolve to permit the full potential of such vast information resources to be realized.

With the availability of workstations across the campus, it is possible that foreign language instruction could be improved through their utilization. The computer's infinite patience and the rapidity of its feedback to the student could be combined to provide a language tutor of great effectiveness. In addition, the workstation could also be used to develop foreign (and even English) language composition proficiency through the use of word processing, spell checking, and textual analysis.

Electronic music continues to develop on the campus. Mixed analog and digital devices are evolving into purely digital units. The eventual ubiquity of workstations will provide increasing possibilities for music creation and performance, as well as study and analysis. Specialized electronic facilities will be needed for advanced scholarship.

V. Computing in Social Sciences

Every student in the social sciences should be able to analyze numerical data using statistical packages. Skills in reducing voluminous or complex data to pictorial, graphical form should be developed by our students. Other techniques and methodologies for the analysis of qualitative data should also be studied with computer-based practicum a standard feature.

The large number of data sets extant and the possibilities for collecting more information through formal sample survey methods give the faculty and students opportunities for testing complex hypotheses and validating past conjectures.

Experiments in the social sciences are most chanllenging because of their multifactorial nature. Computer-simulated experiments may be conducted instead of the "real thing" giving the student the opportunity to vary particular variables and to understand social processes, including random behavior. Large scale computers together with modeling and simulation software are necessary ingredients for "virtual" experiments to be carried out.

Maps are particularly useful in the social sciences, but students rarely get to study from them. Handling paper maps either is too much drudgery or access is too little owing to the fragility of the maps themselves. Digitized maps would be stored in the electronic library for viewing with the general purpose workstation. Software would exist to create composite maps handling the task of rescaling differing maps where necessary. The electronic maps would be always available and would not deteriorate with use over time.

Data acquisition in the social sciences will involve computers to a substantial degree. For instance, psychology experiments will use data acquisition with many variables being observed with or without real-time intervention and feedback to the experimental subjects. Data acquisition will also involve computer-assisted questionnaire interrogation of the respondent either directly by computer-driven protocol or indirectly by an interviewer assisted by the computer. Students and faculty will take advantage of such data collection instrumentation as they develop the more empirical components of the social sciences.

VI. Computing in Science

Historically the computer has been used in science as a calculating engine. Almost no area of modern science today can do without the arithmetic processing capabilties of the computer. As supercomputers become more available, it will be for their speed in performing arithmetic operations that they will be most valued. Of course, the computer is excellent at manipulating symbols which just happens to be what is needed in analyzing data describing sequences of base-pairs in molecules of DNA. Simple and complex patterns of base-pairs may be searched for or retrieved as in a library.

As in the social sciences, the computer is a useful tool in real-time data acquisition whether the object to be studied is a comet or a quark, a protozoan or a brain, an explosion or a climate. The computer may also be used to control the experiment by measuring activities and following a prespecified protocol.

Modeling - the building of abstractions of physical phenomena - is of critical importance in science. Students will need to be able to manipulate models changing variables to learn about the dynamics of a particular situation. Graphical aids will permit the integration of information from many replications of basic experiments. Mathematical equations have been the workhorses of modeling in the past; in the future it will be the graphics produced on the computer workstation, even when the calculations themselves are done using the fastest supercomputers.

Simulation goes hand-in-hand with modeling. Much of what students are supposed to learn in science laboratories could be better delivered via computer-simulated experimentation, rather than in "wet" laboratories. Especially for students who do not need to become technically proficient in handling glassware or animal preparations or electrical circuits, "wet" labs should follow computer-simulations of the objects, principles, and methods to be studied. How many heart-lung preparations have been spoiled and rendered useless because students misunderstood what they were to manipulate in "real time." How much glassware has been broken because awkwardness and unfamiliarity overcame curiosity and eagerness. Of course, physically dangerous experimentation even when instructive must be off-limits in the wet lab, but the computer's lab can handle this domain as well. What is being recommended is computer simulation followed by real laboratory experience, not a substitution of the real by the "virtual" experiment.

VII. Computing in Engineering Sciences

Engineering education and research are being affected by the near total saturation of the various engineering sub-disciplines by computers. The terms computer-assisted design (CAD), computer-assisted manufacturing (CAM), and computer-integrated manufacturing (CIM) are used to describe much of the focus of the new engineering curriculum. Pressures from the competitive international marketplace are almost dictating the use in all ways and forms of the microprocessor and the robot.

The engineering sciences share the calculational needs of the pure sciences. Supercomputers are critical for designing the automobile of tomorrow, from the shape to the configuration of the engine's internal combustion chambers themselves. Our students must learn how to use these new supercomputer tools for manipulating the designs and the structures, integrating the subsystems, and studying the complex interactions of forces, physical sizes, and economic trade-offs. Again, modeling and simulation are key approaches for both the student and the professional engineer. It is not surprising to see that the rate of change in the use of sophisticated computer-based tools is at least as great in the university as it is in practice in the "real world." The economic reality of the marketplace is bringing change that is a challenge to cope with and manage for both professor and professional engineer.

High-performance workstations with sophisticated graphics software are becoming the standard tool for engineers. A practical matter for the Berkeley campus is the challenge of finding enough space to house computer laboratories for student learning. This is especially a problem where the use of the computer in the curriculum and in research is so fundamental.

VIII. Computer Science

When over eighty percent of all students entering Berkeley state as their goal to take at least one course in computer science, one sees an especially large teaching responsibility to be discharged by the computer science faculty. Of course, the faculty have their research obligations as well. Berkeley faculty are playing a major leadership role in both academic and non-academic computing. Taken together, one could hardly find a busier or more productive group on the campus.

There has developed an important synergy between engineering and computer science at Berkeley; both disciplinary specialty groups are interacting with spectacular results coming forth. New software is being created to take advantage of newly developed hardware and new hardware is being created with Berkeley developed software tools. These activities have evolved into a cyclical process with each turn producing still greater gains than were seen before. This type of activity involving faculty sorting themselves out into several affinity groups and arranging their own shared intellectual agendas could be a model to groups of faculty across the whole of the campus.

The dynamic activities in computer science research are changing the very tools all of academia will be using. In fact the rate of change has been so great for so long that there is now a substantial distance between common computing practice on the campus and "state of the art" as it has developed in the computer science group. An important part of the campus's planning for information systems and computer technology must take place with input from computer science faculty. Together the administration and the faculty can develop the best computing environment possible for the Berkeley campus.

IX. Strategies for Campus-wide Computing

If you don't know where you want to go, then any path will take you there. These words are a paraphrase from Carroll's Through the Looking Glass, and suggest that the campus would do well to develop a comprehensive and coherent set of strategies for campus-wide computing. During the past eighteen months a strategic planning effort was initiated. The result has produced a document for the file and a plan to put into action; it has also resulted in a continuous process for seeking input from all members of the campus community, faculty, students, administration, and staff. The strategies are being improved by the process of participation. A major element of the strategies comes from the fact that computing is not just for specialists anymore, that every one wants computing access and services, and that every one wants to have a say in the way computing evolves on the campus.

The elements of the campus's computing strategies are based upon the following points:

- There is a universal campus communications network and every one is connected to it. There are no "islands."
- There are standards for interfacing devices to the network; emerging standards are important in the fast-changing technology of communications.
- Computing power is arranged hierarchically from the individual desktop to the departmental work-group to the organizational supercomputers to the specialty services located off-campus.
- The fundamental building block of computing is the general-purpose, high-functionality workstation; it is deployed throughout the institution for use by faculty, students, administration, and staff.
- The library is the academic information center of the campus and is integrated into the strategies for information systems and computing technology.
- The administrative data bases for financial services, student record keeping and services, human resources and personnel services, fund-raising and development are organized as institutional resources for information sharing with appropriate access and control. Data bases and administrative processing are evolving independently of one another.
- There are a variety of devices in use for the output of all forms of graphics and images and for the input of all forms of text by character

scanning and of composite documents consisting of drawings, logos, icons, handwriting, as well as text, by image scanning.

- All classrooms are equipped for computer use with workstations, networking, and high-resolution projection equipment.

- There is a staff of instructional technology specialists to collaborate with faculty and instructors in the use of information technology resources; the curriculum evolves to take advantage of appropriate technologies.

- Innovations using information technology are evaluated and improvements are sought and developed; usage is refined.

- There is a transfer of technology between the campus and other schools and between the campus and society at large. Technology is transferred both inward and outward.

- The library becomes both the distributor of and the access point for all academic information resources, including software and data sets.

- The computer center becomes the campus-wide archive for academic and administrative information, as well as the information storage facility. It also provides the facilities for backing up data sets which are used elsewhere in the computing hierarchy. It is responsible for off-site storage of copies of data.

X. Models of Usage

The campus computing environment is being developed to support universal use of computers by students. The minimal computing environment for undergraduates would include word and text processing, spreadsheet use, bibliographic searching, use of statistical packages with graphics, access to on-line numerical and textual data bases, electronic mail and electronic bulletin board facilities, and mastery through programming of digital computer principles and methodologies.

The model computing environment for graduate students would consist of access to definitive bibliographic search facilities of the particular discipline, use of reference data stored on-line, technical word processing even with exotic notations and symbols, data acquisition and file management systems for research data, statistical packages and graphics for data reduction and analysis, electronic mail and bulletin boards, publication-quality graphics software and hardware, modeling packages, and simulation software.

The library would be fully automated, including the deployment of a complete on-line catalog for books, serials, and other items for reference and scholarship. The on-line circulation system would keep track of the location of borrowed works and materials. The library would use the computer to maintain a comprehensive data base for authority control of all scholarly works, for acquisitions processing, as well as for the associated business functions of librarianship. The library would augment its reference services to include data base searching. Eventually the library would offer electronic document delivery service to the individual user's workstation by way of the campus communications network. Browsing in the electronic research library of the future would be developed to permit both physical and logical serendipity to occur.

Although not central to the academic plan, it will be important that the campus have the best model computing environment for academic supporting staff and the administration; this would be developed to complement the other models. Intra-office activities would involve the sharing of common resources of hardware, software, and data sets. Inter-office communications would be facilitated by electronic mail, paperless forms processing using the workstation, access to applications running on large, shared computer systems, calendaring and meeting scheduling systems, and phone messaging and logging subsystems. Text processing would be facilitated by use of sophisticated software for correspondence, the preparation of manuscripts and other pre-publication forms, and for archiving documents and scholarly reprint collections. Software would exist for the production of charts, diagrams, and other graphics on slides and other media. Data base systems would exist for equipment inventory control, building and room descriptive data, departmental inventory control, on-line visual catalog of equipment and stores for ordering and purchasing and then eventual reconciliation of payment. Financial processing would be facilitated by computer for grant administration and reporting, for special analyses using spreadsheet tools, financial budgeting and planning, and departmental expense tracking and reporting.

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